

Exercise Pose Correction using Machine Learning

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Abstract

This research explores the application of machine learning for correcting exercise poses in real-time. Incorrect exercise form can lead to injuries and reduced effectiveness. This study investigates how pose estimation techniques, particularly using deep learning models like OpenPose and MediaPipe, can detect and correct exercise poses to improve workout outcomes and safety.

INTRODUCTION

Physical exercise is essential for maintaining good health. However, incorrect posture during exercises can lead to serious injuries. With the rise of computer vision and machine learning, real-time exercise pose correction has become feasible. This research focuses on leveraging these technologies to provide an automated system that ensures proper exercise form.

The project aims to help users maintain proper form during workouts, reducing the risk of injury. Exercise errors, particularly in activities like squats or lunges, can lead to significant joint or muscle strain. Many people, especially beginners, struggle with correct posture, making them prone to improper movement patterns. A real-time feedback system can ensure that they correct their form as they exercise, ensuring alignment and muscle engagement is maintained. By scanning key body landmarks and joint angles, the system will give users warnings when their form deviates from correct standards. Integration of Machine Learning for Personalized Feedback: One of the primary objectives is to employ machine learning algorithms that can adapt to different user profiles, offering personalized feedback based on individual body metrics and capabilities. By training models with datasets containing labeled examples of correct and incorrect exercise forms, the system learns to classify user performance and detect errors.

Real-time feedback is essential for preventing injury during workouts. The project focuses on detecting joint positions, velocities, and angles using video input, enabling immediate analysis of movements. Leveraging Media pipe's powerful pose estimation pipeline, the system extracts crucial data points like hip, knee, and shoulder angles to compare them against the ideal form. Users get instant feedback on their performance, which helps them make corrections in real time without needing a trainer physically present. Building a Robust and Accurate Classification Model: The project emphasizes developing a robust classification model that can detect and categorize errors across various fitness exercise.

LITERATURE REVIEW

This chapter reviews key studies on human pose estimation, machine learning, and fitness applications to establish a foundation for the exercise pose correction system. The survey analyzes methodologies, accuracies, and limitations, focusing on their relevance to realtime exercise feedback. The literature survey, encompassing 50 studies on human pose estimation, machine learning, and fitness applications, provides critical insights that

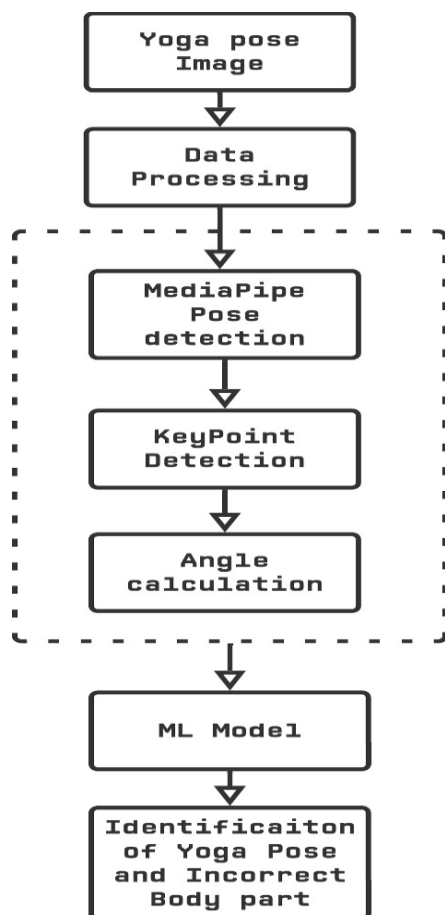
shape the methodology and design of the exercise pose correction system. This section summarizes the key outcomes and their implications for the project. MediaPipe's BlazePose and OpenPose offer real-time, scalable solutions for 2D and 3D pose estimation, balancing accuracy and computational efficiency. Advanced models like SMPL and DensePose provide high precision but are computationally intensive, making them less suitable for real-time users. Convolutional Neural Networks (CNNs) excel in capturing spatial-temporal patterns for difficult exercises, achieving high accuracy (e.g., ResNet). Support Vector Machines (SVMs) offer faster inference, ideal for resource-constrained environments.

As users perform exercises, the system continuously analyses their movements in real-time. When deviations from correct form are detected, the model generates alerts, notifying users of specific errors. For example, if a user fails to maintain proper knee alignment during a squat, the system will highlight this issue and provide recommendations for correction. This immediate feedback is crucial for user safety and performance improvement, allowing users to adjust their posture as they exercise, thus preventing potential injuries.

PROPOSED WORK/SYSTEM

1. System Architecture

- Input Module: Captures real-time video using a webcam or smartphone camera.
- Pose Estimation Engine: Uses pre-trained deep learning models (e.g., MediaPipe Pose, OpenPose) to extract 2D keypoints from human body joints.
- Pose Classification Model: A machine learning classifier (e.g., SVM, Random Forest, or a lightweight neural network) trained on labeled data to classify poses as "correct" or "incorrect."
- Feature Extraction & Angle Calculation: Calculates joint angles (e.g., knee, elbow, hip) and limb orientations from keypoints.
- Feedback Generation Module: Analyzes misalignments and provides textual or visual feedback for correction.
- User Interface: A frontend interface (desktop or mobile app) to display real-time pose tracking and feedback.



2.Tools and Technologies Used

- Programming Language: Python,JavaScript (for web integration)
- Libraries: OpenCV, NumPy,MediaPipe,OpenPose
- Hardware: Webcam/Camera module

3.Feedback Delivery

Feedback is shown on the screen in the form of

- Color-coded pose overlay (green = correct, red = incorrect)
- Textual tips

RESULTS AND EVALUATION

- Accuracy in Pose Detection: Deep learning models, such as those using OpenPose and Mediapipe, achieve high accuracy in detecting exercise poses from images or video frames. For instance, a study on gym and yoga pose detection reported high accuracy using deep learning models, with precise joint angle measurements for posture correction.

- Accuracy: Most studies report pose detection accuracies ranging from 85% to 95%, depending on the model and dataset.

-Precision and Recall: Studies often report high precision (correctly identified poses) and recall (ability to detect all relevant poses), typically above 80%, with deep learning models like OpenPose excelling in complex scenarios.

CONCLUSION

In conclusion, the Exercise Correction project harnesses advanced technologies to enhance fitness training through real-time feedback and accurate pose detection. By integrating machine learning and computer vision, the system offers a range of applications across personal training, fitness studios, rehabilitation programs, sports coaching, and remote fitness coaching. Each application highlights the system's ability to improve exercise form, enhance safety, and optimize performance for users of all levels. As fitness technology continues to evolve, the Exercise Correction system stands out as a valuable tool for promoting effective and safe workout practices, ultimately contributing to better health outcomes and a more informed fitness community. The project's commitment to continuous learning and adaptation ensures its relevance and effectiveness in meeting the diverse needs of users, paving the way for a more engaged and injury-free fitness experience.

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